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ABSTRACT

The purpose of this study was to determine if an effective conservation training procedure would be one in which a child was confronted with opposing points of view. Subjects were 108 children with a mean age of 6.7 years. In two experiments, a group of three children (generally one nonconserver and two conservers) was required to respond with one group answer to a series of standardized conservation problems. When tested again individually, all subjects made significant gains in conservation judgments and explanations on the same problems, on a parallel form of those problems, and on new problems. Nonconservers made the greatest gains. Conservation was found to be related to an analytical cognitive style in one study. (Author/AJ)

THE ACQUISITION OF CONSERVATION THROUGH SOCIAL INTERACTION

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Over fifty years ago in his first book, The Language and Thought of the Child, Piaget suggested that a necessary condition for the movement from the stage of preoperational or egocentric thought to more mature stages of thought was the occurrence of repeated communication conflicts between children. These would require the young child to attend to another child's point of view and perspective, and the ability to maintain a perspective of another or to take another's role appears to be related to operational modes of thought (Flavell, 1967) and to the opportunities for social interaction (Neale, 1961). Since nonconservation is the salient mode of preoperational thought, one would expect that an effective conservation training procedure would be one in which the child was confronted with opposing points of view. This expectation was investigated in the two experiments that follow in which the child's point of view was brought into conflict with other children's points of view.

Method

Subjects. In experiment I there were 57 children, 28 boys and 29 girls, whose mean age was 6.70 years (SD = .72 years) from kindergarten and first grades of a middle class suburban Minneapolis elementary school. In experiment II there were 51 first graders, 28 boys and 23 girls, with a mean

age of 6.74 (SD = .31 years) from a suburban parochial elementary school in Wilmington, Delaware.

Procedure. In the first of three sessions, all subjects in both experiments were given individually Form A of the Concept Assessment Kit (Goldschmid and Bentler, 1968), which provided a standardized testing procedure for six conservation problems (two-dimensional space, number, substance, continuous quantity, weight, and discontinuous quantity). Two points were given for each correct problem, one point for a correct judgement and one point for an explanation that noted reversibility, compensation, or invariant quantity. In experiment I, 19 groups of three subjects were formed. In all but four groups in experiment I, one nonconserver (subjects with scores from 0-4 on Form A) was grouped with two conservers (subjects with scores from 10-12 on Form A). The remaining subjects (with scores from 6-12) were grouped in four groups of three subjects (2 higher scores and 1 lower). In experiment II, there were the following kinds of groups of three children: (1) six groups (one subject with a score of 0 and two subjects with score of 12 on Form A), (2) five groups (one subject with a score of 0 and two subjects with scores from 8-10 on Form A), (3) four groups (two subjects with scores from 1-3 and one subject with a score of 6 or 7 on Form A), (4) two groups (three subjects with scores of 4, and a group of three subjects, with scores of 1, 2 and 3 on Form A).

In a second session each group of three subjects in both experiments was presented as a group with same the problems from Form A of the Concept Assessment Kit. In each group, subjects were told that they could not receive a score until all of them agreed on the answer to each problem. Subjects were given five minutes to solve each problem. E started with the lowest scorers on Form A, and asked each child in a group to answer a

problem, and when there was disagreement between children, they were directed to discuss the problem, and explain to each other why they had said what they had. Subjects were allowed to manipulate the conservation stimuli. E gave no information or reinforcement for correct or incorrect answers.

In the critical third session each subject was tested alone, as in the first session. Conservation problems from Form B, Form C, and lastly Form A of the Concept Assessment Kit were presented. Form B consisted of parallel problems on the same concepts as Form A (viz. two dimensional space, number, substance, continuous quantity, weight, and discontinuous quantity), but different conservation stimuli or different conservation transformations were used. Form C tested the conservation of two new concepts, length and area. There were three area and three length conservation problems on Form C. As on Form A, each problem on Forms B and C, was scored one point for the correct judgement and second point for the appropriate explanation of that judgement. Thus the maximum score on any form was 12.

After the three sessions, subjects in experiment I were presented with a picture matching conceptual style test based on those of Kagan, Moss, and Sigel (1963). For each of ten groups of three line drawings, subjects were asked to pick, "two pictures that were alike or could go together in some way," and to explain, "what is the same about them?" Subjects reasons were scored as analytic or nonanalytic by the standards given in Kagan, Moss, and Sigel (1963). Analytic explanations were those that based the similarity of the total pictures on the identity or similarity of any parts of the total pictures; nonalytic responses based the judgement on something else.

Results

Scores between 0 and 6 were taken to indicate nonconservation on that Form, and scores between 7 and 12 were taken to indicate conservations.

In both experiments significant numbers of subjects who scored between 0 and 6 (nonconservers) on Form A scored between 7 and 12 (conservers) on Form A, Form B, and Form C after they had been exposed to the group session on Form A. In experiment I the shifts from nonconservation (score 0-6) on the pretest Form A to conservation (7-12) on posttest Form A ($\chi^2 = 14.06$, $p < .001$), from nonconservation on pretest Form A to conservation on posttest Form B ($\chi^2 = 13.06$, $p < .001$), and from nonconservation on pretest Form A to conservation on posttest Form C ($\chi^2 = 7.56$, $p < .01$) were significant by the McNemar test (table 1). By the same test, these shifts were also significant in experiment II between pretest Form A and posttest Form A ($\chi^2 = 16.06$, $p < .001$), between pretest Form A and posttest Form B ($\chi^2 = 17.05$, $p < .001$), and between pretest Form A and posttest Form C ($\chi^2 = 16.40$, $p < .001$).

Insert table 1 about here

The mean score for the seventeen nonconservers (table 1) on pretest Form A in experiment I was 2.35 and the mean score of these subjects on posttest Form A, on posttest Form B, and on posttest Form C was 11.41, 10.18, and 8.82 respectively. The differences between the mean score of these subjects on pretest Form A and the mean scores of subjects on posttests Form A, B, and C were all significant at the .001 level by the t test ($t = 14.79$, $t = 11.57$, and $t = 7.99$ respectively). The mean score for conservers on pretest Form A was 10.77, and it was 11.90 on posttest Form A, 11.55 on posttest Form B, and 11.40 on posttest Form C. The differences between these mean scores were significant between pretest A and posttest A ($t = 5.17$, $p < .001$) and between pretest A and posttest B ($t = 3.15$, $p < .01$), but not between pretest A and posttest C ($t = 1.70$, $p > .05$).

In experiment II, the mean score for nonconservers on pretest Form A was 1.61 and the mean score of these subjects on posttests Form A, Form B, Form C was 8.08, 8.38, and 8.19 respectively. The mean differences between pretest Form A and each of the posttests (A,B,C) were significant at the .001 level by the t test (t = 6.74, t = 7.32, and t = 7.51 respectively). Eleven nonconservers in experiment II had scores of 0 on pretest Form A; their mean scores on posttests A, B, and C were 7.27, 7.09, and 6.45 respectively, and by the t test these differences between pre and posttest means were significant at the .01 level. However, of these eleven nonconservers about half scored as conservers on posttests A, B, C (5, 6, and 5 Ss respectively). A McNemar analysis of the shifts from nonconservation on pretest A to conservation on the posttests indicated that only the shift between pretest A and posttest B was significant for these subjects (χ^2 = 4.16, $p < .05$).

In experiment II fifteen nonconservers (scores between 1 and 6) had a mean score of 2.80 on pretest Form A. The mean scores of these subjects on posttest Forms A, B, C, were 9.60, 9.33, and 10.00 respectively, and the mean differences between pre- and posttests were all significant at the .001 level by the t test (t = 7.11, t = 6.98, and t = 11.09 respectively). Of these fifteen nonconservers on pretest A, nearly all conserved on the posttests (12 on Form A; 12 on Form B, and 15 on Form C), and these shifts from nonconservation to conservation were significant by the McNemar test between pretest A and posttest A (χ^2 = 10.08, $p < .001$), pretest A and posttest B (χ^2 = 10.08, $p < .001$), and pretest A and posttest C (χ^2 = 13.06, $p < .001$). Conservers (scores between 7 and 12) in experiment II had a mean score of 10.37 on pretest A, and mean scores of 11.91, 11.87, and 11.08 on posttests

A, B, and C respectively. These differences in mean scores between pretest A and each posttest, as in experiment I, were significant between pretest A and posttest A ($\underline{t}$ = 3.99, $p < .001$), pretest A and posttest B ($\underline{t}$ = 3.88, $p < .001$), but not between pretest A and posttest C ($\underline{t}$ = 1.29, $p > .05$).

The norms for the Concept Assessment Kit are separated by sex. The appropriate mean score in the norms for Form A was 7.15 for girls and 5.55 for boys, and the mean score on pretest Form A was 7.72 for all girls, and 6.77 for all boys in the experiments. The differences in mean scores between norm subjects and those in the experiments were insignificant by the $\underline{t}$ test (girls, $\underline{t}$ = .48, $p > .05$; boys, $\underline{t}$ = .97, $p > .05$). However, differences in mean scores between these groups on posttest A (girls, mean = 10.52, $\underline{t}$ = 3.06, $p < .01$; boys mean = 11.25, $\underline{t}$ = 5.00, $p < .01$) were significant by the $\underline{t}$ test. On Form B the mean score was 7.37 for girls and 7.64 for boys in the norm groups. The means for experimental subjects on posttest B were 10.48 for girls and 10.66 for boys, and the differences in mean scores on Form B between norm and experimental groups were significant by the $\underline{t}$ test (girls, $\underline{t}$ = 2.66, $p < .01$; boys, $\underline{t}$ = 2.29, $p < .01$). On Form C the mean score was 6.82 for girls and 5.03 for boys in the norm groups. The mean scores on posttest C were 10.38 for girls and 10.03 for boys, and the differences in mean scores on Form C between the norm and experimental groups were significant by the $\underline{t}$ test (girls, $\underline{t}$ = 4.24, $p < .001$; boys, $\underline{t}$ = 6.02, $p < .001$).

In both experiments there were no significant differences in the proportions of conservers and nonconservers on pretest Form A between boys and girls (experiment I $\chi^2 = 0.53$, $p > .25$; experiment II, $\chi^2 = 0.49$, $p > .25$).

However there were the usual differences in these proportions between older and younger children in experiment I, but not in experiment II. In experiment I there were significantly fewer conservers and more nonconservers in the group below 6.66 years (median age) than in the group above it (χ^2 = 6.06, $p < .02$); in experiment II there were insignificant differences in these proportions between the group above and below the sample's median age of 6.50 years (χ^2 = 0.94, $p > .25$). In experiment II, the mean score for the first graders who had been in kindergarten was 6.06, and for those who had not had the experience the mean score was 5.81. The difference in these mean scores was not significant (t = 0.18, $p > .05$).

In experiment I there was a significant association between conservation on pretest Form A and more than the median number analytic responses on the picture matching task (χ^2 = 3.85, $p < .05$; r = .30, $p < .05$).

Differences in the proportions of conservers and nonconservers in experiment I and conservers and nonconservers in experiment II on pretest A were significant (χ^2 = 4.18, $p < .05$). The mean score for subjects in experiment I was 8.16 and the mean score for subjects in experiment II was 5.85 on pretest Form A, and the difference in these means was significant (t = 2.67, $p < .02$).

Discussion

The issue of whether or not conservation development can be accelerated is plagued in the research literature by theoretical doubts of its possibility, conflicting empirical results, and ambiguity in the criterion of conservation. Theoretically conservation is taken to be one of many symptoms of concrete operational thought, and in a sense the manipulation of responses

which indicate conservation is as trivial as any exercise that manipulates the symptom and not the disease. Although the acceleration of conservation responses without an attending presence of other aspects of operational thought may be an empty accomplishment in developmental theory, it is not one in education. The conservation response, regardless of its theoretical status, is an important behavior in itself for educational psychology. Procedures, like the present social conflict procedure, that induce or facilitate conservation behavior, and also have classroom applications constitute a part of the psychology of curriculum and instruction.

The data indicate that social conflict or interaction is an important mediator of cognitive growth. Virtually all the children, regardless of the proportion of conservers and nonconservers in the training group, made significant gains in conservation performance after the social conflict situation. Since there were no significant differences in conservation performance between the children in the test's norms and the children in these experiments on pretest A, the norm groups can serve as a control group. Performance on posttests A, B, C was significantly higher than that of the normative children on these tests, and indicates that the training effect cannot be attributed to retesting or maturation effects.

The most impressive gains were made by those subjects who gave some evidence, however little, of conservation on the pretest. In general conservation studies have been most successful with nonconservers who were close to the threshold of conservation. On the other hand, of fifteen children from experiments I and II who scored 0 on the pretest, eight had scores of 11 or 12 on the posttests. It should be noted that these gains include the more demanding conservation criterion (Gruen, 1966) of an appropriate explana-

tion for the conservation judgment. It should also be noted that there was considerable transfer to different forms of the same concepts and to different concepts.

Brison (1966) was able to induce some form of conservation in half a group of nonconservers with a combination social training procedure and conflict-reversibility instruction. Since there was no deliberate instruction in the present experiments, the data emphasize the effectiveness of social interaction even in the absence of any systematic instructional effort. It was the case that the children often resorted to reversibility explanations to persuade their lagging colleagues, and that in the social situations nonconservers acquiesced and generally gave conservation responses after the third problem (mean = 2.76) on Form A and generally (80%) did not give a nonconserving response after they had once given a conserving one.

It is not clear what the nonconservers learned in the social situation that sustained them in the individual situation. It probably was not a set to say, "the same," and to give a rote, but correct, explanation, since all Forms contained items in which the stimuli were unequal before the conservation transformation. The reversibility principle, although strictly speaking incorrect (Murray and Johnson, 1969), and the invariant quantity principle ("You did not add or subtract anything;" "they were the same before, and you didn't change the weight, etc.") were rules that would lead to the correct response on all Forms if the child had grasped the initial relationship (equal or unequal) between the stimuli before they were transformed. If these principles were acquired, and the children's reasons indicate that in some sense they were, they would account for the very high level of performance on the transfer tasks, Forms B and C.

The significant relationship between conservation and analytic cognitive style, although not a strong one, is consistent with Nodleman's (1965) finding that conservers tended be field - independent. It also provides another small conjunction between cognitive style and intellectual development, and allows speculation about conservation as a style of knowing the world.

Smedslund (1966) in a review of the research on the many conditions that have been found to be inconsistently related to the acquisition of operational thought concluded that "the occurrence of communication conflicts is a necessary condition for intellectual decentration" and recommended that the key interaction needed for the growth of intelligence was not so much between the individual and his environment as it was between the individual and those about him. The present data support his hypothesis and emphasizes as Piaget has (Sigel, 1969) the educational role of social interaction in the transition from egocentrism to operational thought.

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Footnote

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Table 1

Numbers of Conservers (C) and Nonconservers (NC) Who Shifted or Were Consistent in Experiments I and II between Pretest A and Posttests A, B, and C.

	Posttests					
	Form A		Form B		Form C	
Pretest Form A	C	NC	C	NC	C	NC
Experiment I						
C	40	0	40	0	38	2
NC	16	1	15	2	14	3
Experiment II						
C	25	0	25	0	24	1
NC	18	8	19	7	21	5